



PATENT
CASE NO.: 9436/028

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re Application of:)	
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James B. Tieken)	
)	
Serial No.: 10/672,505)	Examiner: Einsmann, Margaret V.
)	
Filed: September 26, 2003)	Art Unit: 1751
)	
For: REFRIGERANT BLEND)	

RULE 132 DECLARATION

I, James B. Tieken, do hereby declare that I am the inventor of the invention disclosed and claimed in the above-referenced patent application. I have reviewed the Office Action mailed from the United States Patent and Trademark Office on July 23, 2004, in this matter, and the patent references cited therein.

In the Office Action mailed July 23, 2004, the Patent Examiner rejected certain claims of my application under 35 U.S.C. §103(a) as being unpatentable over Rhodia Limited, GB 2,327,427 in view of Matsushita Electrical Industrial Co., Inc., EP 539,952. According to the Examiner, the GB reference is directed to refrigerant compositions comprising pentafluoroethane (R-125), 1,1,1,2-tetrafluoroethane (R-134a), and butane (R-600) or isobutane (R-600a), and the Matsushita EP reference is directed to a combination of R-125, R-134a and R-290 (propane). Thus, according to the Examiner, it would have been obvious to substitute propane for a portion of the butane in the GB formulation because the mixture of R-290 with R125 and R134a is used for the same purpose as the Rhodia mixture of R-600 or R-600a with R-125 and R134a. I respectfully disagree with the Examiner's contention, and offer the following comments and test data in support of my position.

The flammability of replacement refrigerant mixtures has been an ongoing concern in the refrigeration industry. A refrigerant mixture should be formulated so that it is non-flammable not only in its initial formulated condition, but also after significant leakage from the refrigeration system. Thus, to the extent possible, the industry has sought to minimize the use of flammable components in a refrigerant blend. However, in many CFC and HCFC replacement refrigerants that use mineral oil as a lubricating oil, it is generally necessary to add a small percentage of lower hydrocarbons to the refrigerant composition to improve the miscibility of the lubricating the oil in the refrigerant. Normally, the hydrocarbon will comprise less than about 8 weight percent of the refrigerant blend, and in most cases, less than 5 weight percent. Since hydrocarbons are flammable, the amount of hydrocarbon in the composition should be limited to an amount that does not adversely affect the flammability of the refrigerant composition.

The percentage of the various components that make up a refrigerant composition does not change appreciably from its original formulation during routine usage. If the refrigerant is nonflammable as formulated, then it remains so throughout normal usage. However, when a leak develops in the system, the dynamics of the system are subject to change. This is particularly true when the refrigerant is a blend of individual components, as is very common with present-day refrigerant compositions. In this event, the individual components of the blend evaporate or leak from the system at different rates, due to the different vapor pressures of the respective components. This evaporation results in constantly-changing percentages of the components in both the liquid and vapor phase. As a result, it is not uncommon for the percentage of hydrocarbon in either the liquid phase, or in the vapor phase, to exceed the flammability limit at some point during the leakout. When this occurs, the refrigerant composition can become flammable.

My inventive formulation addresses this problem by including two discrete hydrocarbon portions. The first hydrocarbon portion includes a specified hydrocarbon refrigerant having a boiling point lower than the boiling point of R-134a, and the second hydrocarbon portion includes a specified hydrocarbon refrigerant having a boiling point higher than the boiling point of R-134a. By splitting the hydrocarbon component into two groups in this manner, the

hydrocarbon portions evaporate at different rates, and tend to cancel each other out during refrigerant leakout. For example, since the rate of evaporation of isobutane (from Group B) is high relative to that of R-134a, the level of this hydrocarbon increases in the vapor phase with reference to R-134a during leakout. Since the rate of evaporation of propane (from Group A) is low relative to that of R-134a, the level of this hydrocarbon decreases in the vapor phase with reference to R-134a during leakout. As a result of these competing actions, the total amount of hydrocarbon does not exceed the flammability limit. In a similar manner, the hydrocarbon percentage in the liquid phase does not exceed the flammability limit during leakout.

Thus, by splitting the hydrocarbon component in this manner, the percentage of hydrocarbon in both the vapor phase and the liquid phase of my inventive composition remains below the flammability limit. If the hydrocarbon component was not split in this manner, then the percentage of hydrocarbon in either the vapor phase or the liquid phase (depending upon the vapor pressure of the particular hydrocarbon in the blend) would exceed the flammability level. This is shown in the data attached to this Declaration as Exhibit A. It is also shown in Example 1 provided at pages 9-11 of the present application.

Exhibit A presents the results of computer simulation tests that I performed using the NIST Refleak program (Version 2.0) to compare the changes in the composition of a blend of R-125, R-134a and a hydrocarbon component throughout a leakage cycle. Tests were set up to compare a formulation having a hydrocarbon component made up of about 1.5 wt. percent isobutane and about 1.5 wt. percent propane, with a formulation having a hydrocarbon component of about 3 wt. percent propane, and another formulation having about 3 wt. percent isobutane. The remaining components were common to the three tests, namely about 60 wt. percent R-125 and about 37 wt. percent R-134a. The three simulated formulations were each subjected to a controlled leakout, and the change in wt. percent of each component was recorded. The results are shown in Exhibit A. The results are recorded as decimal equivalents to wt. percent.

As shown in the section of Exhibit A titled "Total hydrocarbon component throughout leak tests", when isobutane is the sole hydrocarbon, the percentage in the as formulated vapor

phase is below 2%. This amount is generally considered insufficient to carry oil effectively in HFC refrigeration systems. When propane is the sole hydrocarbon, its' percentage in the vapor phase in the as formulated state exceeds the flammability limit. However, when the hydrocarbon component is split into separate isobutane and propane portions, the blend does not become flammable during leakout, and there is enough hydrocarbon component in the as formulated state, and much of the leakout, to insure good oil return. After some of the refrigerant is lost from a refrigeration system, most refrigeration systems will shut down to lessen damage to the system by running low on refrigerant.

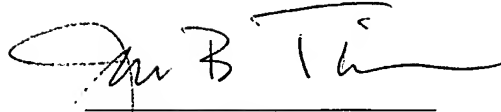
When my inventive blend is used, even as a certain portion of the hydrocarbon component evaporates into the vapor phase, another portion remains with the liquid phase. This ensures that both phases maintain hydrocarbon levels at acceptable levels, not only as originally formulated, but also after significant leakage from the system. In addition, sufficient hydrocarbon remains present in the refrigerant to maintain the miscibility of the lubricant oil in the refrigerant.

Neither of the cited references teaches a hydrocarbon component comprising a hydrocarbon having a boiling point lower than the boiling point of R-134a, **and** a hydrocarbon having a boiling point higher than the boiling point of R-134a. The GB reference combines R-125 and R-134a with a hydrocarbon taken from my Group B components, namely butane, and the Matsushita reference combines R-125 and R-134a with a hydrocarbon from my Group A components, namely propane. As shown in Exhibit A, formulations such as those taught in the cited references are either flammable in the as formulated state (propane) or after leakout, or they do not include sufficient hydrocarbon to carry oil effectively through the refrigeration system. Thus, with either formulation, significant flammability problems remain. These flammability problems are not experienced with my inventive formulation.

I further declare under penalty of perjury pursuant to the laws of the United States of America that the foregoing is true and correct, and that this Declaration was executed by me on October 16, 2004, at Indianapolis, Indiana.

Serial No.: 10/672,505

Filed: September 26, 2003



James B. Tieken



EXHIBIT A

Hydrocarbon leakout comparison – Propane/isobutane mixture vs. propane and isobutane

R-125/propane/R-134a/isobutane (60/1.5/37/1.5)

Percent leakout	0	10	20	30	40	50	60	70	80
R-125 liquid	.5938	.5829	.5700	.5548	.5363	.5133	.4840	.4449	.3891
vapor	.6933	.6868	.6776	.6671	.6531	.6358	.6113	.5774	.5248
R-134a liquid	.3765	.3896	.4045	.4217	.4421	.4667	.4976	.5381	.5956
vapor	.2609	.2715	.2838	.2983	.3156	.3369	.3643	.4016	.4571
Propane liquid	.0147	.0123	.0101	.0079	.0059	.0042	.0027	.0016	.0007
vapor	.0380	.0328	.0276	.0224	.0175	.0129	.0087	.0053	.0026
Isobutane liquid	.0150	.0152	.0154	.0156	.0157	.0158	.0157	.0154	.0146
vapor	.0078	.0089	.0110	.0122	.0138	.0144	.0157	.0157	.0155

R-125/propane/134a (60/3/37)

Percent leakout	0	10	20	30	40	50	60	70	80
R-125 liquid	.5988	.5888	.5769	.5626	.5448	.5223	.4930	.4532	.3954
vapor	.6841	.6796	.6738	.6661	.6557	.6410	.6198	.5876	.5351
R-134a liquid	.3717	.3855	.4013	.4195	.4411	.4672	.4997	.5423	.6024
vapor	.2506	.2615	.2742	.2893	.3075	.3301	.3592	.3986	.4572
Propane liquid	.0295	.0257	.0218	.0179	.0141	.0105	.0073	.0045	.0023
vapor	.0653	.0589	.0520	.0446	.0368	.0288	.0210	.0138	.0076

R-125/R-134a/isobutane (60/37/3)

Percent leakout	0	10	20	30	40	50	60	70	80
R-125 liquid	.5985	.5856	.5710	.5540	.5340	.5098	.4763	.4404	.3840
vapor	.7191	.7082	.6951	.6792	.6569	.6373	.6055	.5727	.5181
R-134a liquid	.3714	.3837	.3977	.4139	.4331	.4564	.4889	.5239	.5785
vapor	.2624	.2724	.2839	.2974	.3137	.3338	.3627	.3948	.4472
Isobutane liquid	.0301	.0307	.0313	.0321	.0329	.0338	.0348	.0357	.0365
vapor	.0185	.0194	.0210	.0234	.0267	.0289	.0308	.0325	.0347

Total hydrocarbon component throughout leak tests

Propane and isobutane

Percent leakout	0	10	20	30	40	50	60	70	80
liquid	.0297	.0275	.0255	.0235	.0216	.0200	.0184	.0170	.0153
vapor	.0458	.0417	.0386	.0346	.0313	.0273	.0244	.0210	.0181

Propane

liquid	.0295	.0257	.0218	.0179	.0141	.0105	.0073	.0045	.0023
vapor	.0653	.0589	.0520	.0446	.0368	.0288	.0210	.0138	.0076

Isobutane

liquid	.0301	.0307	.0313	.0321	.0329	.0338	.0348	.0357	.0365
vapor	.0185	.0194	.0210	.0234	.0267	.0289	.0308	.0325	.0347